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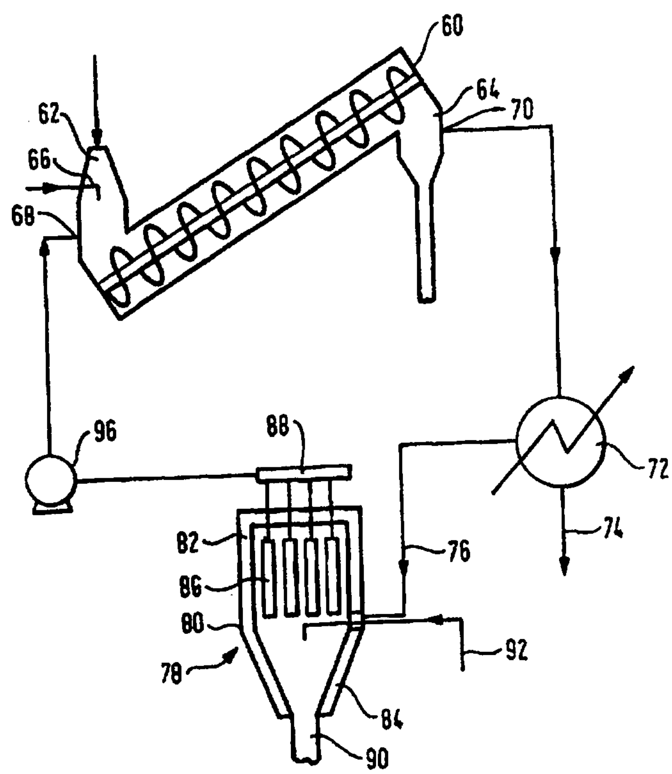
(57) Abstract

A process for recovering aroma from ground coffee. The ground coffee is transported through an elongated mixing zone while being agitated. At the same time, an aqueous fluid is sprayed into the elongated mixing zone to moisten the ground coffee as the ground coffee is being transported and agitated. Aroma gases released by the moistened ground coffee in the elongated mixing zone are drawn off and are cooled to condense moisture. The aroma gases are then cryogenically frozen to provide an aroma frost. The aroma frost is recovered.



Recovery of Coffee Aroma

This invention relates to a process for the recovery of coffee aroma from roast and ground coffee and to the aroma so recovered. The recovered aroma is useful for aromatizing instant coffee.

Aromas are an important part of many products since consumers associate certain aromas with certain products. If the product lacks the aroma associated with it, consumer perception of the product is adversely affected. This is particularly a problem in the field of instant coffees, although it also exists in other fields. Instant coffee powders which are obtained from commercial processes involving extraction, concentration and drying, are usually substantially aroma-less. For this reason, it is conventional to recover coffee aromas which are given off during the processing of the instant coffee and to reincorporate these aromas into the instant coffee powder.

The coffee aromas may be recovered at several points during processing of the instant coffee. However aromas are most commonly recovered during grinding of the roasted beans and by steam stripping of the coffee extract prior to concentration and drying of the coffee solids. It has also been suggested to recover aromas given off during filling of the extraction cells with extraction liquid.

The recovery of aroma from ground coffee is disclosed in US patent 3,535,118. This patent discloses a process in which roast and ground coffee is placed in a column and maintained at about 40°C. The bed of coffee is then moistened by spraying water on it to assist in displacing aromas from the coffee particles. An inert gas, usually nitrogen, is heated to about 44°C and introduced into the column from beneath the bed. As the inert gas passes up through the bed, it strips the aromas from the coffee particles. The inert gas is then fed to a condenser which is operated at a temperature of about 5°C to condense water in the inert gas. The de-watered inert gas is ultimately fed to a cryogenic condenser to condense the aroma as a frost. The frost is then recovered.

One of the problems perceived to arise with this process is that it results in prolonged pre-wetting of the coffee grounds outside of the extraction cell or column. According to Sivetz, M and Desrosier N.W.; 1979; Coffee Technology, AVI Publishing Company, Inc., page 334, this practice is bad because it "causes staling of ground coffee in less than an hour, accompanied by a heavy, undesirable flavor and a loss in natural coffee volatiles". Sivetz and Desrosier

strongly advocate that first wetting of the coffee grounds should occur in the extraction cell or column. Consequently recovery of aroma from ground coffee by pre-wetting it is not common practice; despite ground coffee being a good source of aroma.

Another problem with the process is that the bed of coffee is not wet uniformly due to channelling of the wetting fluid in the bed. Consequently the amount of aroma released is not optimum.

Therefore there is still a need for a process for recovering aroma from ground coffee.

Accordingly, in one aspect, this invention provides a process for recovering aroma from ground coffee, the process comprising:

transporting the ground coffee through an elongated mixing zone while subjecting the ground coffee to agitation;

introducing an aqueous fluid into the elongated mixing zone to moisten the ground coffee as the ground coffee is being transported and agitated;

removing aroma gases released by the moistened ground coffee from the elongated mixing zone and cooling the removed aroma gases to condense moisture from the aroma gases; and

cryogenically freezing the aroma gases to provide an aroma frost.

The invention provides the advantage of an efficient process for the recovery of coffee aroma from ground coffee. The simultaneous transport and agitation of the ground coffee results in homogeneous wetting of the ground coffee and excellent release of aroma from the ground coffee. Further, because the process is not static, the moistened ground coffee is delivered from the elongated mixing zone and may be directly fed to an extraction cell or column for extraction. Consequently, the moistened ground coffee may be subjected to extraction almost immediately afterwards. Therefore problem of staling which led Sivetz and Desrosier to consider the practice of pre-wetting to be bad, need not arise.

Preferably the amount of aqueous fluid introduced into the elongated mixing zone is sufficient to provide a mass ratio of ground coffee to aqueous fluid of about 1:5 to about 5:1, especially about 1:2 to about 2:1; and more preferably a mass ratio of ground coffee to aqueous fluid of about 1:1.5 to about 2:1. Particularly suitable is a mass ratio of ground coffee to aqueous fluid of about 1:1. The moisture content of the ground coffee is preferably increased to a level of about 15 % to about 60% by weight during the process; especially about

40% to about 60% by weight. The aqueous fluid is preferably water or coffee extract but may also be steam or a mixture of steam and water or coffee extract.

In one embodiment, the ground coffee may be transported and agitated by causing one or more conveying screws to rotate in the elongated mixing zone. The use of two conveying screws is particularly preferred.

In another embodiment, the ground coffee may be mechanically agitated as the ground coffee is transported through the elongated mixing zone to soften the particles of the ground coffee. The ground coffee may be mechanically agitated by rotating one or more shafts in the elongated mixing zone; each shaft having a plurality of beating elements projecting from the shaft to agitate and transport the ground coffee. Preferably two shafts are rotated in the elongated mixing zone; one shaft rotating faster than the other. The elongated mixing zone may comprise two elongated mixing chambers which are in fluid communication along their length; one shaft rotating in one mixing chamber and the other shaft rotating in the other mixing chamber. Preferably the mixing chamber containing the shaft which rotates at a slower speed has a diameter larger than that of the other mixing chamber.

Preferably the aroma gases released from the ground coffee are removed from the elongated mixing zone by causing an inert carrier gas to flow through the elongated mixing zone. The inert carrier gas is preferably nitrogen. The carrier gas may conveniently flow co-current to the direction of transport of the ground coffee.

Preferably the aqueous fluid is heated to a temperature of about 50°C to about 120°C prior to being introduced into the elongated mixing zone. More preferably the temperature of the aqueous fluid is about 70°C to about 95°C.

The mean residence time of the ground coffee in the elongated mixing zone is preferably in the range of about 30 seconds to about 4 minutes; more preferably about 1 minute to about 2.5 minutes.

The aroma gases are preferably cooled to a temperature in the range of about 0°C to about 20°C to condense the moisture; more preferably from about 5°C to about 10°C The cooling may take in one or more cooling stages. The aqueous liquid condensing in the condenser may be recovered and, since it contains aqueous aroma components, may be used as an aroma source.

The aroma gases are preferably cryogenically frozen by simultaneously introducing the aroma gases and liquid inert gas into a confined space; sufficient liquid inert gas being introduced to maintain the temperature in the confined

space below about -80°C but above the boiling point of the liquid inert gas. Further, the frozen aroma may be separated from the non-condensing gas and vaporized inert gas by removing the gases from the confined space through one or more filters.

The mean particle size of the ground coffee is preferably in the range of about 1.3 mm to about 2 mm.

In another aspect, this invention provides aroma recovered by a process as defined above.

Embodiments of the invention are now described, by way of example only, with reference to the drawings in which:

Figure 1 is a schematic cross-section of an apparatus for moistening ground coffee and releasing coffee aroma;

Figure 2 is a cross-section of line AA' of figure 1; and

Figure 3 is a schematic representation of a process for recovering aroma from ground coffee.

To carry out the process of recovering aroma, the ground coffee must be introduced into a suitable apparatus which defines an elongated mixing zone in which the ground coffee may be agitated, transported and moistened. Numerous examples of suitable apparatus are available; for example screw conveyors and preconditioners.

One example of a suitable apparatus is a preconditioner as illustrated in figures 1 and 2. Freshly ground coffee is introduced into a feed hopper 2. A screw feeder 4 then transports the ground coffee from the bottom of the feed hopper 2 to the top of a vertical feed column 6. The lower end of the vertical feed column 6 is connected to an upwardly-opening solids inlet 30 of a preconditioner 8. An air lock 100 is positioned in the vertical feed column 6 to prevent gases from escaping from the preconditioner 8. Hence the ground coffee falls down the vertical feed column 6, through the air lock 100, and into the preconditioner 8.

The preconditioner 8 comprises an elongated conditioning vessel 10 defining a first frustocylindrical mixing chamber 12 and a second frustocylindrical mixing chamber 14. The first and second mixing chambers 12, 14 are in communication with one another along the length of the elongated conditioning vessel 10. The second mixing chamber 14 has a diameter which is larger than the diameter of the first mixing chamber 12. The solids inlet 30 is positioned at the upstream end of the preconditioner 8 while a downwardly-

opening solids exit 32 is positioned at the opposite, downstream end of the preconditioner 8.

A first mixing shaft 16 extends along the longitudinal axis of the first mixing chamber 12 and supports several beating elements 18 which project radially from the first mixing shaft 16. The beating elements 18 are spaced from one another along the length of the first mixing shaft 16 and about the circumference of the first mixing shaft 16. Each beating element 18 has an elongated blade portion 20 which extends to just short of the inner surface 22 of the first mixing chamber 12. Each elongated blade portion 20 is inclined so that it advances the ground coffee along the elongated conditioning vessel 10 as the first mixing shaft 16 is rotated.

A second mixing shaft 24 extends along the longitudinal axis of the second mixing chamber 14 and supports several paddles 26 which project radially from the second mixing shaft 24. The paddles are spaced from one another along the length of the second mixing shaft 24 and about the circumference of the second mixing shaft 24. Each paddle has a large flat portion 28 at its tip which is inclined so that it advances the ground coffee along the elongated conditioning vessel 10 as the second mixing shaft 24 is rotated.

Each mixing shaft 16, 24 is connected to a drive (not shown) to rotate the shafts. Preferably, the first mixing shaft 16 is rotated at a speed greater than the speed of the second mixing shaft 24. Also, the first mixing shaft 16 preferably rotates in a direction opposite to that of the second mixing shaft 24.

A liquid inlet 34 to the elongated conditioning vessel 10 is positioned a small distance downstream from the solids inlet 30 and above the mixing shafts 16, 24. More than one liquid inlet 34 may be provided and the inlets 34 may be spaced along the length of the elongated conditioning vessel 10. An aqueous liquid feed line 36 is connected to the liquid inlet 34. Gas inlets 38 for steam may be provided along the length of the elongated conditioning vessel 10 beneath the mixing shafts 16,24. The gas inlets 38 are connected to a steam supply line 40. An aroma outlet line 42 extends from the solids outlet 32. Alternatively, the aroma outlet line may extend from the downstream end of the preconditioner 8 itself. An air lock 102 is positioned in the solids outlet 32 downstream from the aroma outlet line 42.

Further details of the construction of the preconditioner 8 may be obtained from US patent 4,752,139; the disclosure of which is incorporated by reference.

The preconditioner 8 is commercially available and may be purchased from Wenger Manufacturing, Inc. of Sabetha, Kansas, USA.

Upon entering the preconditioner 8, the coffee particles making up the ground coffee are immediately subjected to the action of the rotating beating elements 18 and paddles 26. The beating elements 18 and paddles 26 cause the coffee particles to move in a general direction towards the solids outlet 32. The rotation of the beating elements 18 and paddles 26 also causes the coffee particles to move from one mixing chamber 12, 14 to the other mixing chamber 12,14; and back again.

While the coffee particles are being subjected to the action of the beating elements 18 and paddles 26, aqueous liquid (usually in the form of water or coffee extract) is sprayed onto the coffee particles through the liquid inlets 34. Also steam may be introduced through the gas inlets 38.

Due to the action of the beating elements 18 and paddles 26, the ground coffee and the aqueous fluid are homogeneously mixed. Also, due to the action of the beating elements 18 and the paddles 26, the matrix structure of the coffee particles appears to soften. This, and the general beating action, may facilitate release of trapped aroma gases and ingress of the aqueous fluid.

The aroma gases evolved from the coffee particles may be removed by sweeping a carrier gas through the system and removing it through the aroma gas outlet 42. Alternatively, the aroma gases may be drawn off using vacuum connected to the aroma gas outlet 42. Preferably, the gases are removed by introducing a sweeping gas into the vertical feed column 6, at a point downstream from the air lock 100, which then sweeps through the preconditioner 8.

The wet coffee particles which are transported to the solids outlet 32 fall through the solids outlet 32, from where they may be transferred to an extraction system. In this way, extraction may be carried out relatively soon after wetting of the ground coffee; avoiding the problem of staling.

Plainly, the ground coffee may be moistened in preconditioner which is different from the preconditioner 8. For example, it is not necessary for the elongated conditioning vessel 10 to have mixing chambers of different diameters or have different mixing shafts. Also it is not necessary to have two mixing chambers; one mixing chamber would be adequate. Similarly the apparatus need not have two mixing shafts; one mixing shaft or more than two mixing shafts would operate adequately. It is also not essential have the number and arrangement of beating elements 18 and paddles 26 illustrated in figures 1 and 2.

Other suitable preconditioners may be obtained from Wenger Manufacturing, Inc; Extru-tech Inc (of Sabetha, Kansas, USA) and the like.

Another suitable apparatus which defines an elongated mixing zone in which the ground coffee may be agitated, transported and moistened, is a screw conveyer. Screw conveyers are well known in the art and are usually formed of an elongated mixing vessel in which one or more conveying screws extend from one end to the other. The flights of the conveying screws are best arranged so that little or no compression is applied on the particles of ground coffee. A twin screw conveyor is particularly preferred.

In a manner similar to that described above with reference to the preconditioner 8 illustrated in figures 1 and 2, the screw conveyor has a solids inlet incorporating an air lock, a liquid inlet adjacent the solids inlet, a carrier gas inlet adjacent the solids inlet, a solids outlet incorporating an air lock and an aroma outlet line. If desired, the screw conveyor may have a steam inlet. In use, the ground coffee entering the screw conveyor is conveyed from the solids inlet to the solids outlet by the one or more screws. Aqueous liquid is introduced through the liquid inlet and is mixed with the ground coffee by the one or more screws. Gases released from the ground coffee are removed through the aroma outlet line. Carrier gas, if required, is introduced through the carrier gas inlet.

Suitable mixers may be obtained from Wenger Manufacturing, Inc., Bühler AG and Clextral SA. Also other continuous mixers which are able to transport and agitate coffee particles to obtain homogeneously moistened coffee particles, may be used.

Referring now to Figure 3, a process for capturing the aroma is described. Ground coffee is introduced into a suitable mixer 60 through a solids inlet 62 which contains an air lock (not shown). The mixer 60 may be a preconditioner 8 as described above, a screw conveyor as described above or other suitable continuous mixer. The feed hopper 2 and screw feeder 4 described with reference to figure 1 may be used to introduce the ground coffee into the mixer 60. Once in the mixer 60, the ground coffee is transported, while being agitated, to a solids outlet 64 at the opposite end of the mixer 60. An air lock (not shown) is positioned in the solids outlet 64.

An aqueous liquid is sprayed into the mixer 60 through an liquid inlet nozzle 66 positioned near the solids inlet 62. Therefore, as the ground coffee is transported through the mixer 60, it is mixed with the aqueous liquid and

moistened. The moistened ground coffee falling through the solids outlet 64 is then transported directly to a suitable extraction apparatus (not shown).

The aqueous liquid may be at any desired temperature; especially in the range of about 20°C to about 120°C. It is found, however, that better results can be obtained if the temperature is above about 50°C; for example from about 70°C to about 95°C. If desired, steam at pressures of about 101 kPa (0 psig) to about 170 kPa (10 psig) may be introduced into the mixer 60 through gas inlets (not shown) to supplement the aqueous liquid. In this case, the mass flow rate of steam is suitably 5 to 10 times less than the mass flow rate of the ground coffee into the mixer 60. Alternatively, sufficient steam may be introduced into the mixer 60 to totally replace the aqueous liquid.

The ratio of ground coffee to aqueous fluid fed into the mixer 60 is suitably in the range of about 5:1 to about 1:5, preferably about 1:2 to about 2:1; with about 1:1 being particularly suitable

The mean residence time of the ground coffee particles in the mixer is sufficient to achieve uniform wetting of the coffee particles; for example in the range of 30 seconds to about 4 minutes. Although longer times are acceptable, they are not necessary and provide no advantage.

An inert gas is blown by a fan or compressor 96 through a gas inlet 68 to the mixer 60 positioned near the liquid inlet nozzle 66 and the solids inlet 62. The gas used as the sweeping gas may be any suitable gas which is sufficiently inert so that it does not degrade the coffee or coffee aromas; for example nitrogen, carbon dioxide and helium, or mixtures thereof. Nitrogen gas as the primary gas is particularly suitable.

The inert gas flows through the mixer 60 co-currently with the ground coffee and aqueous liquid, conveying with it aroma gases released from the ground coffee. The inert gas, which is now aroma-laden, is drawn off through a gas outlet 70 positioned near the solids outlet 64 and led to a condenser 72. The condenser 72 is operated at a temperature sufficiently low to condense most of the water vapour in the inert gas. A temperature of below about 50°C is suitable although cooling to below 20°C is preferred. Preferably more than one condenser is used; each succeeding condenser being operated at a lower temperature. Preferably the downstream condenser is operated at a temperature of about 0°C to about 10°C.

The aqueous liquid which condenses in the condenser 72 is also a good source of aqueous aroma components and is recovered through liquid aroma line

74. The aqueous aroma components may be recovered in any of many conventional processes; for example by running the aqueous liquid through a stripping column or the like. Alternatively it may be mixed with liquid coffee extract and processed in a conventional manner.

The inert gas and the aroma components which do not condense in the condenser 72 are then fed through a gaseous aroma line 76 to a cryogenic aroma condenser 78. Many suitable aroma condensers are known and have been reported in the literature. Preferably however, the aroma condenser 78 has a housing 80 formed of an upper cylindrical section 82 and a lower conical section 84. The lower end of the conical section 84 terminates in a discharge opening 90. Several cylindrical filters 86, preferably porous stainless steel, extend vertically within the upper cylindrical section 82. The inner bore of each cylindrical filter 86 is connected to a gas manifold 88.

An inert gas in liquid form is sprayed into the housing 80 from a liquid gas source (not shown) through a gas input line 92. The liquid inert gas is preferably the same as the inert gas used to carry the aroma components; more preferably nitrogen. Sufficient liquid inert gas is sprayed into the housing to maintain the housing 80 at a temperature below about -80°C, for example at about -110°C or lower, but sufficiently high such that the liquid inert gas vaporises in the housing 80.

Therefore most aroma components introduced into the housing 80 freeze into a frost while the inert gas carrying it does not. The aroma frost falls to the bottom of the housing 80 and out of the discharge opening 90. The inert gas passes through the cylindrical filters 86 and into the manifold 88. Some aroma frost collects on the cylindrical filters 86 but this may be removed by pulsing inert gas back through the cylindrical filters 86 at regular intervals to dislodge the frost. The frost falling through the discharge opening may be recovered by mixing it into a suitable substrate; for example coffee oil, coffee oil emulsion, or heavy coffee liquor. The aroma recovered in this way may be utilised as is conventional.

Further details of the operation of the cryogenic aroma condenser 78 can be obtained from US patents 5,182,926 and 5,323,623; the disclosures of which are incorporated by reference. Plainly other cryogenic aroma condensers may be used; for example that disclosed in US patent 5,030,473.

The inert gas entering the gas manifold 88 is drawn through the fan or compressor 96 and returned to the mixer 60 through the gas inlet 68. Excess inert

gas may be bled off at some suitable point to maintain steady state conditions. Because large amounts of carbon dioxide are released from the ground coffee in the mixer 60 and the carbon dioxide does not condense in the cryogenic aroma condenser 78, the inert gas recycled to the mixer 60 contains a percentage of carbon dioxide.

It will be appreciated that numerous modifications may be made to the embodiments described above without departing from the scope of the invention. For example, more than one cryogenic aroma condenser 78 may be used; the condensers being arranged in series and at decreasing temperatures. It is also possible to cause the inert gas to flow counter-current to the ground coffee in the mixer 60. It is also not necessary to recycle the inert gas in the cryogenic aroma condenser 78 back to the mixer 60; although it is more cost effective to do so.

Example 1

A batch of about 550 kg of roasted and ground coffee is placed in a feed hopper. The average particle size of the ground coffee is about 2 mm. The ground coffee is fed to a Wenger 7DDC preconditioner (obtained from Wenger Manufacturing, Inc. of Sabetha, Kansas, USA) at a rate of about 2.3 kg/minute (5 lb/minute). The diameter of the smaller mixing chamber of the preconditioner is about 0.25 m (10 inches) while that of the larger mixing chamber is about 0.35 m (14 inches). The mixing shaft in the smaller mixing chamber is rotated at 350 rpm while that in the larger mixing chamber is rotated at 170 rpm.

A coffee extract containing about 11% by weight of soluble coffee solids is sprayed into the preconditioner at a rate of about 2.3 kg/minute (5 lb/minute) through three nozzles. The temperature of the coffee extract is about 82°C (180°F). Nitrogen gas is swept through the preconditioner to remove evolved coffee gases. The coffee particles leaving the preconditioner are fed directly to an empty extraction cell for connection into an extraction system.

The nitrogen gas and coffee gases are run through a condenser operated at about 5°C and almost all moisture in the gases is condensed and removed as an aqueous liquid. The aqueous liquid contains aqueous aroma components and is collected. The dry gases are then fed to a cryogenic aroma condenser as described in US patent 5,182,926. The cryogenic aroma condenser is operated at about -110°C. The aroma frost formed in the aroma condenser falls through the discharge outlet and is mixed into coffee oil using a ribbon blender.

The moistened ground coffee is extracted as is conventional. A sample of the extract is taken and determined to have no stale aromas or flavours.

Example 2

Freshly ground roasted coffee is fed through a gas-tight airlock at a rate of 305 kg/hr into a screw conveyor. The screw conveyor is gas-tight, has an inner diameter of 20 cm and has a single screw which rotates at 16 rpm. Water is sprayed into the screw conveyor at the inlet end of the screw at a rate of 305 kg/hr. The temperature of the water is about 95°C. The mean residence time of the ground coffee in the screw conveyor is about 3 minutes. Thereafter it is discharged as a homogeneously wet mixture through a gas-tight airlock and fed directly to an extraction cell. The ground coffee is extracted as is conventional. A sample of the extract is determined to have no stale aromas or flavours.

Gaseous nitrogen is swept through the screw conveyor, co-currently with the ground coffee, at a rate of 25 m^3/hr. The gaseous nitrogen, which carries aroma gas, CO_2, and water vapour, is removed from the screw conveyor adjacent the outlet end of the screw. The gaseous nitrogen is run through a condenser where it is cooled to about 8°C. Almost all of the water vapour, as well as some aroma components, condense to provide an aqueous aroma liquid at a rate of about 8.8 kg/hr.

The gases leaving the condenser are transferred to a cryogenic aroma condenser as described in US patent 5,182,926 which is operated at about -118°C. The aroma frost formed in the condenser is blended into coffee oil using a ribbon blender and recovered.

Example 3

The process of Example 2 is repeated except that the gaseous nitrogen leaving the screw conveyor is run through three condensers arranged in series. One condenser is operated at 50°C, the next at 30°C and the last at 5°C. The condensate obtained from the first two condensers is added to coffee extract obtained from the extraction cells and subjected to steam stripping. The condensate obtained from the last condenser is mixed with the aroma frost obtained from the cryogenic aroma condenser.

Example 4

The process of example 2 is repeated except that the aroma frost collected in the cryogenic aroma condenser is mixed into an emulsion of coffee extract and coffee oil. The mixture is then sprayed into freeze-dried coffee powder agitated in a tumbler. The coffee solids form a capsule around the coffee oil and the capsules are dried. The capsules are added to a commercial coffee powder. The powder is dissolved in hot water and the resulting beverages presented to a trained panel. The panel determines the beverage to have a good above-the-cup aroma with a brew-like character. The beverages are determined to have better above-the-cup aroma than beverages prepared from the commercial coffee powder alone.

Claims

1. A process for recovering aroma from ground coffee, the process comprising:

transporting the ground coffee through an elongated mixing zone while subjecting the ground coffee to agitation;

introducing an aqueous fluid into the elongated mixing zone to moisten the ground coffee as the ground coffee is being transported and agitated;

removing aroma gases released by the moistened ground coffee from the elongated mixing zone;

cooling the removed aroma gases to condense moisture from the aroma gases; and

cryogenically freezing the aroma gases to provide an aroma frost.

2. A process according to claim 1 in which the mass ratio of ground coffee to aqueous fluid introduced into the elongated mixing zone is 1:1.5 to 2:1.

3. A process according to claim 1 in which aqueous fluid is introduced into the elongated mixing zone to raise the moisture content of the ground coffee to 15 % to 60% by weight.

4. A process according to claim 1 in which the aqueous fluid is water, coffee extract, steam or a mixture thereof.

5. A process according to claim 1 in which the ground coffee is mechanically agitated and transported by causing one or more conveying screws to rotate in the elongated mixing zone.

6. A process according to claim 1 in which the ground coffee is mechanically agitated and transported by rotating one or more shafts in the elongated mixing zone; each shaft having a plurality of beating elements projecting from the shaft to agitate and transport the ground coffee.

7. A process according to claim 1 in which the aroma gases released from the ground coffee are removed from the elongated mixing zone by causing an inert carrier gas to flow through the elongated mixing zone.

8. A process according to claim 13 in which the inert carrier flows co-current to the direction of transport of the ground coffee.

9. A process according to any of claims 1 to 8 in which the aqueous fluid is heated to a temperature of about 70°C to about 95°C prior to being introduced into the elongated mixing zone.

10. A process according to any of claims 1 to 8 in which the mean residence time of the ground coffee in the elongated mixing zone is in the range of 30 seconds to about 4 minutes.

FIG. 1

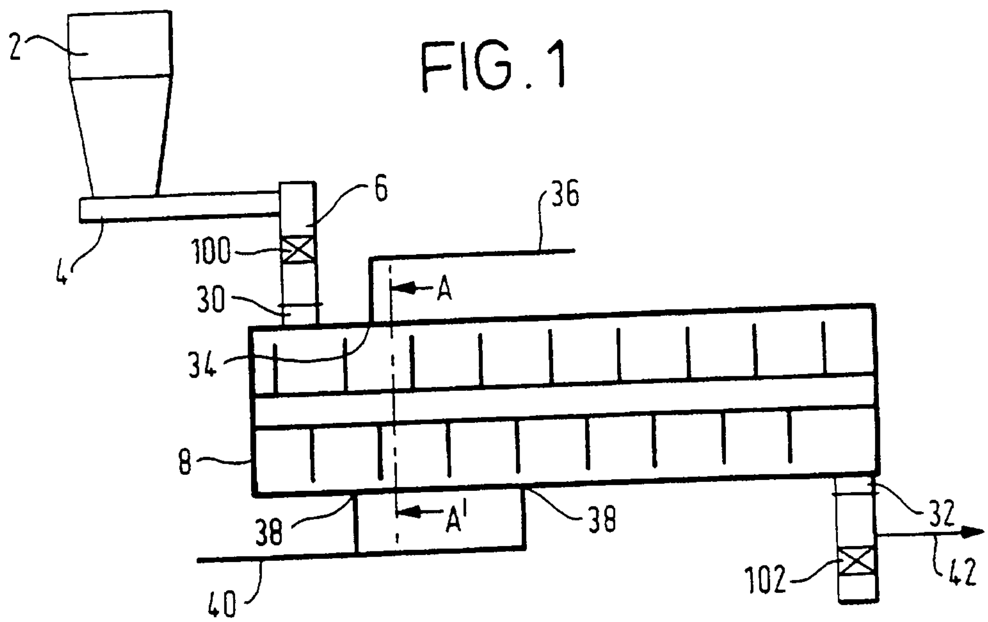

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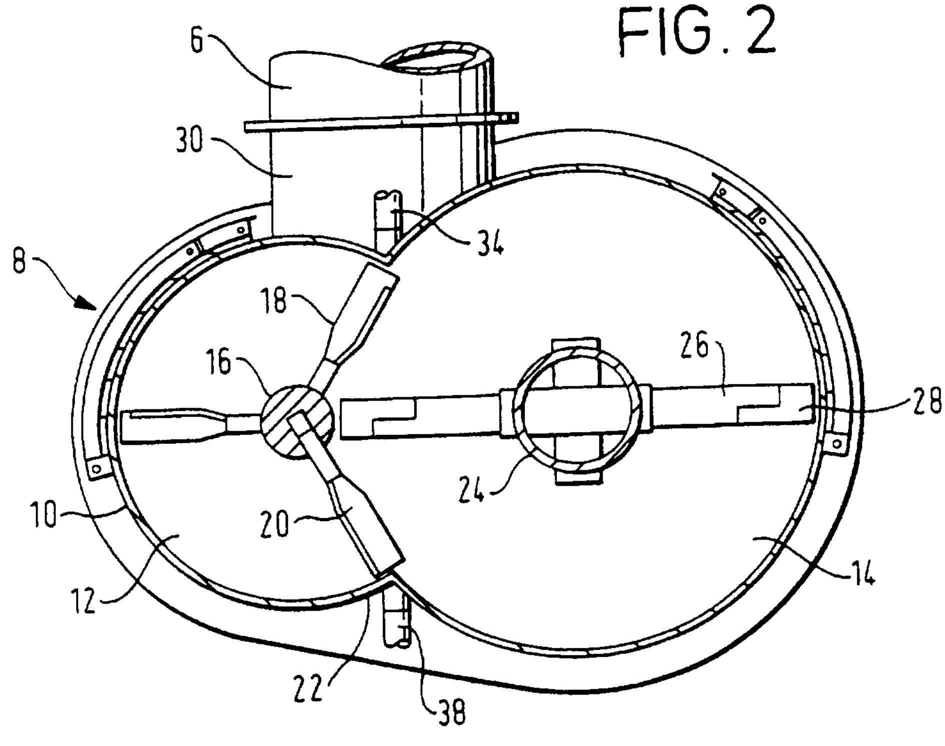
FIG. 2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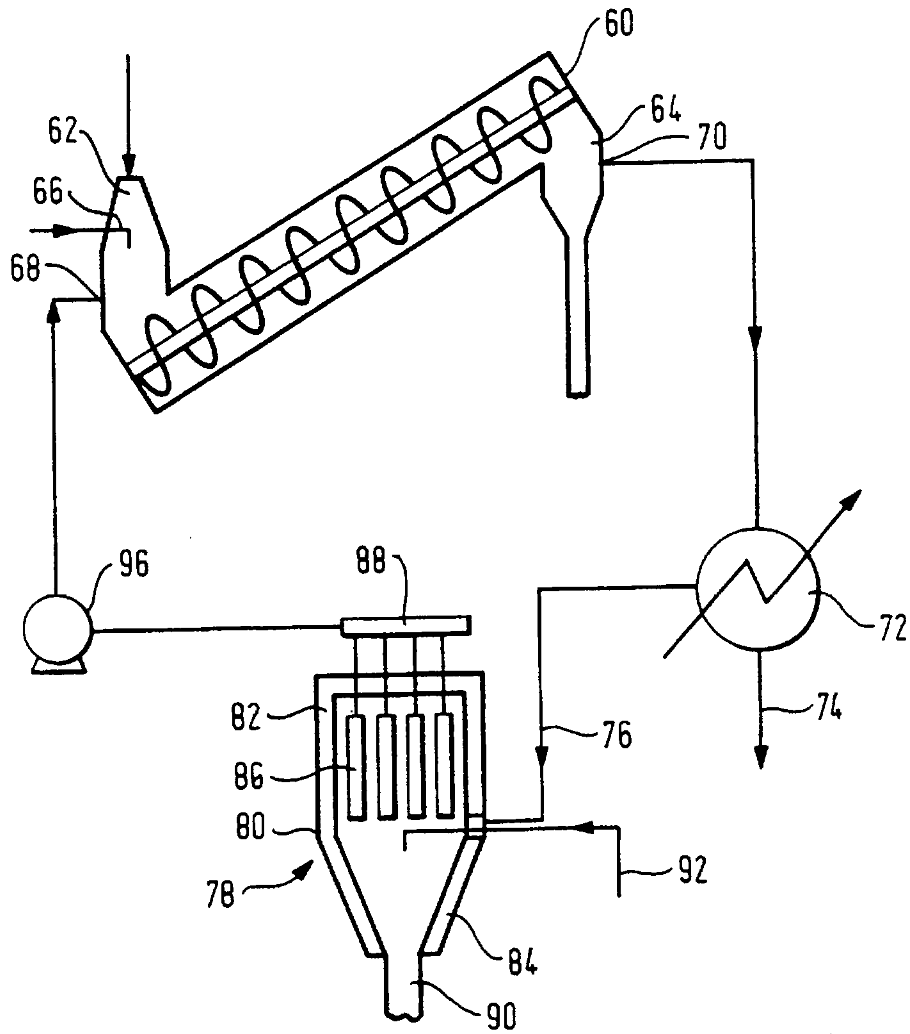

FIG. 3

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 96/04164

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 A23F5/48

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 A23F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US,A,4 100 305 (R. GREGG) 11 July 1978 see claims 1-8; examples I,II ---	1-4,6,10 5,7-9
X	US,A,4 100 306 (R. GREGG) 11 July 1978 see column 4, line 39 - line 44; claims 1-6; example I ---	1-6,10
A	EP,A,0 043 667 (THE PROCTER & GAMBLE CO) 13 January 1982 see claims 1-9; example I ---	1
Y	GB,A,1 466 881 (GENERAL FOODS) 9 March 1977 see page 2; claims 1-7; figure ---	5

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
16 January 1997	06.02.97
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer Desmedt, G

INTERNATIONAL SEARCH REPORT

Inter ·onal Application No
PCı/EP 96/04164

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
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